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Freewheel bearing device and freewheel pulley

The present invention relates to the field of freewheel bearings, in particular sprung freewheel bearings.

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Such devices comprise two elements that can rotate concentrically relative to one another in freewheel mode and between which there is the need to be able to transmit a torque without relative movement between the

10 two elements when the device operates in torque take-up mode. In sprung freewheel devices, a helical spring usually performs the freewheel function. The spring is fixedly attached by one of its ends to one of the two elements of the device and, in one relative direction 15 of rotation between the two elements, rubs without binding on a cylindrical bearing surface of the other element. When the relative movement between the two elements is reversed, the rubbing portion of the spring binds on the cylindrical bearing surface, this binding 20 being caused by the diametral expansion of the spring by the unwinding effect in a cylindrical bearing surface of a housing or by the winding effect on the cylindrical bearing surface of a shaft.

25 Such freewheel devices are used in particular in alternator pulleys in order to prevent the transmission of the acyclicalities of the engine to the alternator, particularly via a belt.

30 By thus being able to temporarily decouple the alternator from the engine, it prevents, for example when there is a sudden drop in engine speed, the alternator becoming the driver and causing a belt voltage reversal. This therefore spares the 35 transmission belt, which enables its service life to be significantly increased.

Reference may be made to document WO A 98/50 709 or to document US A 5 598 913. The bearing function is performed by one or more antifriction bearings or rolling bearings and the freewheel function is

5 performed by a helical spring one end of which is interlocked with a piece connected to an inner rotating portion and a certain number of coils of which interact with the cylindrical bore of an outer piece in order to transmit a torque or no torque between the inner and

10 outer pieces depending on the relative direction of rotation between those two pieces.

Such devices are satisfactory but still have certain disadvantages. When the device is freewheeling, a

15 certain number of coils of the spring rub in the outer piece with a relatively high speed equal to the differential angular speed between the two pieces, for example between the pulley and the hub. This may lead to rapid wear of the spring and undesirable failures of

20 the device.

The invention seeks to increase the service life of freewheel bearings.

25 The invention seeks to reduce the wear on freewheel bearings.

The invention proposes a freewheel bearing device comprising a rolling bearing furnished with a plurality of rolling elements and a cage to retain the rolling elements, and a freewheel furnished with a freewheel spring. Said spring comprises a first portion interacting with the cage and a second portion interacting with an outer and/or inner element, said

30 35 element being directly or indirectly interlocked with a body on which the rolling elements run.

The speed of sliding of the spring relative to the cage or to said element is limited to substantially half the

rotation speed of the bearing. Consequently there is a considerable reduction in the wear of the spring and of the piece on which said spring rubs when it is not transmitting torque. In a relative direction of 5 rotation, the spring is sliding and the freewheel is said to be disengaged. In the opposite direction, the spring is engaged and the freewheel is said to be engaged. A torque may then be transmitted between the outer and inner elements of the bearing.

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By directly interlocked it is meant that said element is either of one piece with said body, or in contact with and attached to said body and indirectly interlocked means that said element is attached to said 15 body by means of one or more interposed pieces.

In one embodiment of the invention, said spring comprises a portion interlocked in rotation with the cage. The spring may be in frictional contact with the 20 outer and/or inner element. Said spring may comprise coils interacting with a cylindrical bearing surface of said element.

In another embodiment of the invention, said spring 25 comprises a portion interlocked in rotation with said element. The spring may be in frictional contact with the cage. Said spring may comprise coils interacting with a cylindrical bearing surface of the cage.

30 In one embodiment of the invention, the freewheel comprises a single spring.

In another embodiment of the invention, the freewheel 35 comprises two springs, for example one mounted between the cage and the outer element and the other mounted between the cage and the inner element.

In one embodiment of the invention, the antifriction bearing comprises an outer race and an inner race. The

rolling elements are then disposed between the outer and inner races. At least one of the races may comprise an axial extension capable of interacting with the spring. The axial extension may be provided with a 5 bearing surface capable of rubbing against the spring or be provided with a bearing surface to which one end of the spring is attached.

Advantageously, the cage comprises an axial extension 10 in contact with the first portion of the spring.

In one embodiment of the invention, the spring is helical.

15 In one embodiment of the invention, the spring has rectangular section. The spring may thus be radially compact.

Said element may be made as a single unit with said 20 body.

The invention also proposes a pulley comprising a freewheel bearing device and a pulley body interlocked with an outer element of the bearing. The freewheel 25 bearing comprises an antifriction bearing furnished with a plurality of rolling elements and a cage to retain the rolling elements, and a freewheel furnished with a spring. The spring comprises a first portion interacting with the cage and a second portion 30 interacting with an outer and/or inner element, said element being interlocked with a body on which the rolling elements run.

As can be seen in figures 1 to 3, a freewheel bearing 1 35 comprises an antifriction bearing 2 and a freewheel 3 mounted between a shaft 4 with an axisymmetric cylindrical outer surface and an outer support 5 having a cylindrical bore 6.

The antifriction bearing 2 comprises an outer race 7, an inner race 8, a row of rolling elements 9 and a cage 10 to retain the rolling elements 9. The outer race 7 has an outer surface 7a mounted, for example fitted, 5 into the cylindrical bore 6 of the outer support 5, a rolling bearing raceway 7b formed on its bore, and two opposing radial transverse surfaces 7c and 7d. The inner race 8 has a bore 8a mounted, for example fitted, onto the outer surface of the shaft 4, a rolling 10 bearing raceway 8b formed on its outer surface, and two opposing radial transverse surfaces 8c and 8d. The rolling elements 9, here balls, are disposed between the rolling bearing raceways 7b and 8b. The cage 10 comprises receptacles evenly distributed in the 15 circumferential direction in which the rolling elements 9 are mounted, portions 11 between the receptacles and a continuous circular portion 12 on one side of the rolling elements 9 radially between the races 7 and 8. The cage 10 is made of molded synthetic material, for 20 example of polyamide reinforced with glass fiber.

The cage 10 also comprises an axial extension 13 extending beyond the radial plane defined by the radial transverse surfaces 7c and 8c of the races 7 and 8. The 25 axial extension 13 is of generally circular shape and has a cylindrical outer surface 13a of greater diameter than that of the bore of the outer race 7, and a cylindrical bore 13b of lesser diameter than that of the outer surface of the inner race 8. The axial length 30 of the extension 13 is close to that of the rolling bearing 2. The cage 10 is made as a single unit. In addition to the axial extension 13 of the cage 10, the freewheel 3 comprises a spring 14 of helical general shape. The spring 14 comprises one end 15 formed of 35 several coils, here three, in contact with the cylindrical bore 6 of the outer support 5, another end 16 formed of several coils, here three, in contact with the outer surface of the shaft 4, and a radial central portion 17 passing through a radial notch formed in the

extension 13 or sunk into the axial extension 13, for example by overmolding. The radial central portion 17 of the spring 14 is thus interlocked in rotation with the extension 13 and the cage 10.

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The device operates by the take-up of torque, when the relative movement of the outer support 5 relative to the shaft 4 occurs in the direction of the arrow indicated in figure 2, for example when the shaft 4 is 10 immobile and when the outer support 5 is driven in the direction of the arrow. Specifically, the cage 10 of the rolling bearing rotating at an angular speed equal to half the difference of the angular speeds of the outer race 7 and inner race 8, if the outer race 7 of 15 the rolling bearing has a relative movement relative to the inner race 8 in the direction of the arrow, the cage 10 rotating more slowly than the outer race 7, the result is that the outer coils of the spring 14 which is connected to the cage 10 by its radial portion 17, 20 have a tendency, by friction on the cylindrical bore 6 of the outer support 5, to tighten in the latter. Simultaneously, the inner end 16 of the spring 14, driven by the cage 10 rolls up and tightens on the shaft 4. The spring 14 thus transmits the torque 25 between the outer support 5 and the shaft 4.

If the radial load on the rolling elements 9 is sufficient and the torque to be transmitted relatively weak, the torque may be transmitted between the outer 30 end 15 of the spring 14 and the shaft 4 via the cage 10 and the rolling element 9 before the inner coils of the end 16 are retightened on the shaft 4. In this case, the inner coils of the end 16 will intervene to transmit the torque if the latter increases above a 35 certain value and causes the rolling elements 9 to slide in their rolling bearing raceway 8b. Naturally, the stiffness of the spring 14 can be chosen such that the torque is not transmitted by the rolling elements 9.

If the direction of the relative movement is reversed between the outer support 5 and the shaft 4, the inner coils of the end 16 of the spring 14 loosen, thereby 5 allowing a relative angular movement with friction between the spring 14 and the shaft 4. The outer coils of the end 15 of the spring 14 also loosen, thereby allowing a relative angular movement with friction between the spring 14 and the cylindrical bore 6 of the 10 outer support 5. The device then operates in freewheel mode.

Numerous variants and applications of the device may be envisaged.

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Figure 4 shows a variant in which the reference numbers of similar elements are retained. The freewheel 3 comprises two independent springs, one inner 19 and another outer 20. The spring 19 is disposed between the 20 bore 13b of the axial extension 13 of the cage 10 and the outer cylindrical surface of the shaft 4 with a plurality of coils, here three, in contact with the bore of the axial extension 13 and one end 21 angularly interlocked with the shaft 4. The outer spring 20 25 comprises a plurality of coils, here three, in contact with the outer cylindrical surface 13a of the axial extension 13 of the cage 10 and one end 22 angularly attached in the bore 6 of the outer support 5, for example by means of a notch 23 formed in said bore 6 30 and into which the end 22 of the spring 20 protrudes.

In one relative direction of rotation between the outer support 5 and the shaft 4, the coils of the springs 19 and 20 rub on the axial extension 13 of the cage 10 and 35 thus allow a rotation without transmission of significant torque. In the other relative direction of rotation, the springs 19 and 20 tighten on the axial extension 13 of the cage 10 and transmit a torque while making the outer support 5 angularly interlocked in one

direction with the shaft 4.

In the embodiment illustrated in figure 5, the freewheel bearing device 1 is mounted in a pulley. The 5 outer support 5 which then forms the pulley body has an outer surface 24 in the form of trapezoidal crenellations adapted to a pulley of the poly-V type. The cylindrical bore 6 is limited by a shoulder 25 formed at one axial end of the outer support 5 and in 10 contact with the transverse surface 7d of the outer race 7.

The shaft is replaced by a hub 26 also having a shoulder 27 delimiting its outer cylindrical surface 15 and allowing an axial positioning of the inner race 8 of the antifriction bearing 2. The hub 26 has a bore 28.

The embodiment illustrated in figure 6 is provided for 20 applications in which the torque to be transmitted is relatively weak. This embodiment is comparable to that in figure 4 except that it has no outer spring. The bore 6 of the outer support 5 also has no notch. The freewheel 3 comprises a single spring, that is the 25 inner spring 19 whose free end 21 is interlocked in rotation with the shaft 4 and whose coils rub on the bore 13b of the axial extension 13 of the cage 10. In locking mode, the coils in radial extension are locked in the bore 13b of the radial extension 13 and 30 therefore interlock the cage 10 with the shaft 4. The rolling elements 9 are therefore also interlocked with the shaft 4 and the outer race 7 interlocked with the outer support 5 remains stationary relative to the shaft 4 insofar as the torque to be transmitted is not 35 too great and the radial load of the antifriction bearing 2 is sufficient. This is a particularly economical embodiment.

The embodiment in figure 7 is also economical with a

single spring, that is the outer spring 20. As for the rest, this embodiment is similar to that of figure 4. As for the embodiment in figure 6, it is an economical variant fitted with a single spring here placed between 5 the radial extension 13 of the cage 10 and the outer support 5.

The embodiment in figure 8 is similar to the embodiment in figure 1 except that the spring has no outer 10 portion. The spring bearing reference number 29 comprises an inner part 15 similar to that in figure 1 and a radial portion 17 facing outward and interfering with the axial extension 13 of the cage 10. More precisely, said axial extension 13 is provided with a 15 notch 18 extending radially outward from its bore over a portion of its radial height and disposed at its free axial end opposite the rolling elements 9. The radial portion 17 of the spring 29 protrudes into said notch 18 and interlocks in rotation the radial portion 17 20 forming one end of the spring 29 with the cage 10.

This embodiment is therefore also economical with a single spring placed on a single side of the cage, here on the inside. In torque transmission mode, the inner 25 portion 15 of the spring 29 is engaged with the shaft 4 whereas in disengaged mode, the coils of the inner portion 15 are in contact with the shaft 4 with a slight friction. The cage 10 then turns freely relative to the shaft 4.

30 The embodiment illustrated in figure 9 is similar to that in figure 1. The freewheel comprises a single spring 30 placed between the axial extension 13 of the cage 10 and the outer support 5. The spring 30 35 comprises coils forming an outer portion 16 similar to that illustrated in figure 1 and a radial portion 17 protruding into a notch 18 extending radially inward from the outer cylindrical surface 13a of the axial extension 13 of the cage 10 and formed at the free

axial end of the extension 13 opposite the rolling elements 9. The radial portion 17 placed in the notch 18 is interlocked in rotation with the cage 10 while the coils forming the outer portion 16 are tightened in 5 the cylindrical bore 6 of the outer support 5 thus providing a transmission of torque, or, in the case of reversal of relative rotation, rotate at the same angular speed as the cage 10 with a slight friction relative to said bore 6 of the outer support 5.

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In the embodiment illustrated in figure 10, the freewheel 3 is integrated into the antifriction bearing 2. More precisely, the outer race 7 comprises an axial extension 31 on the side of the freewheel 3 which has 15 radial dimensions identical to the rest of the outer race 7. Likewise, the inner race 8 comprises an axial prolongation 32 which has the same bore as the inner race 8 and an outer cylindrical surface of lesser diameter, for example substantially equal to that of 20 the bottom of the antifriction bearing raceway 8b. The cage 10 comprises an axial extension 33 with the same inner and outer diameters as the circular portion 12 and as the portions 11 formed between the receptacles in which the rolling elements 9 are disposed. A spring 25 29 similar to that mounted in the embodiment illustrated in figure 8 but of smaller dimension comprises an inner portion 15 provided with a plurality of coils in contact with the outer cylindrical surface of the axial prolongation 32 of the inner race 8, and a 30 radial portion 17 protruding into the axial extension 33 of the cage 10, more precisely protruding into a radial blind hole, not shown, formed from the bore of the axial extension 33 and facing outward, or sunk into the material forming the axial extension 33.

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Thus, the spring 29 has one end, that is the radial portion 17, interlocked in rotation with the cage 10 and another end formed by the coils of the inner portion 15 and which is capable of being either

interlocked in rotation with the inner race 8 in torque transmission mode, or of moving with a slight friction relative to said outer surface of the axial prolongation 32 of the inner race 8 in freewheel mode

5 in which the outer race 7 and the inner race 8 move at different angular speeds. This embodiment is extremely compact and combines the functions of rolling bearing and freewheel.

10 Generally, it is also conceivable to furnish the device illustrated in figure 1 with two springs such as the springs 28 and 29 of the embodiments in figures 8 and 9, thus replacing the spring 14.

15 The embodiment illustrated in figure 10 could perfectly well be equipped with springs of the types illustrated in the other embodiments, notably the spring 14 in figure 1 or be furnished with two springs 29 and 30.

20 Generally, during freewheel operation, the friction between the coils of the spring and the corresponding friction bearing surface is generated at a reduced relative speed arising directly from the differential angular speed between the cage of the antifriction

25 bearing and the race of the antifriction bearing to which the friction bearing surface is connected. Wear of the spring by friction is therefore considerably reduced since the antifriction bearing cage rotates at an angular speed equal to half the difference of the

30 angular speeds of the races. If N is the differential angular speed between the outer race and the inner race of the antifriction bearing in freewheel operation, the differential angular speed between the spring and its friction bearing surface will be equal to $N/2$ according

35 to the invention instead of N in the case of the prior art. Evidently the result is an appreciable increase in the lifetime of the system according to the invention.